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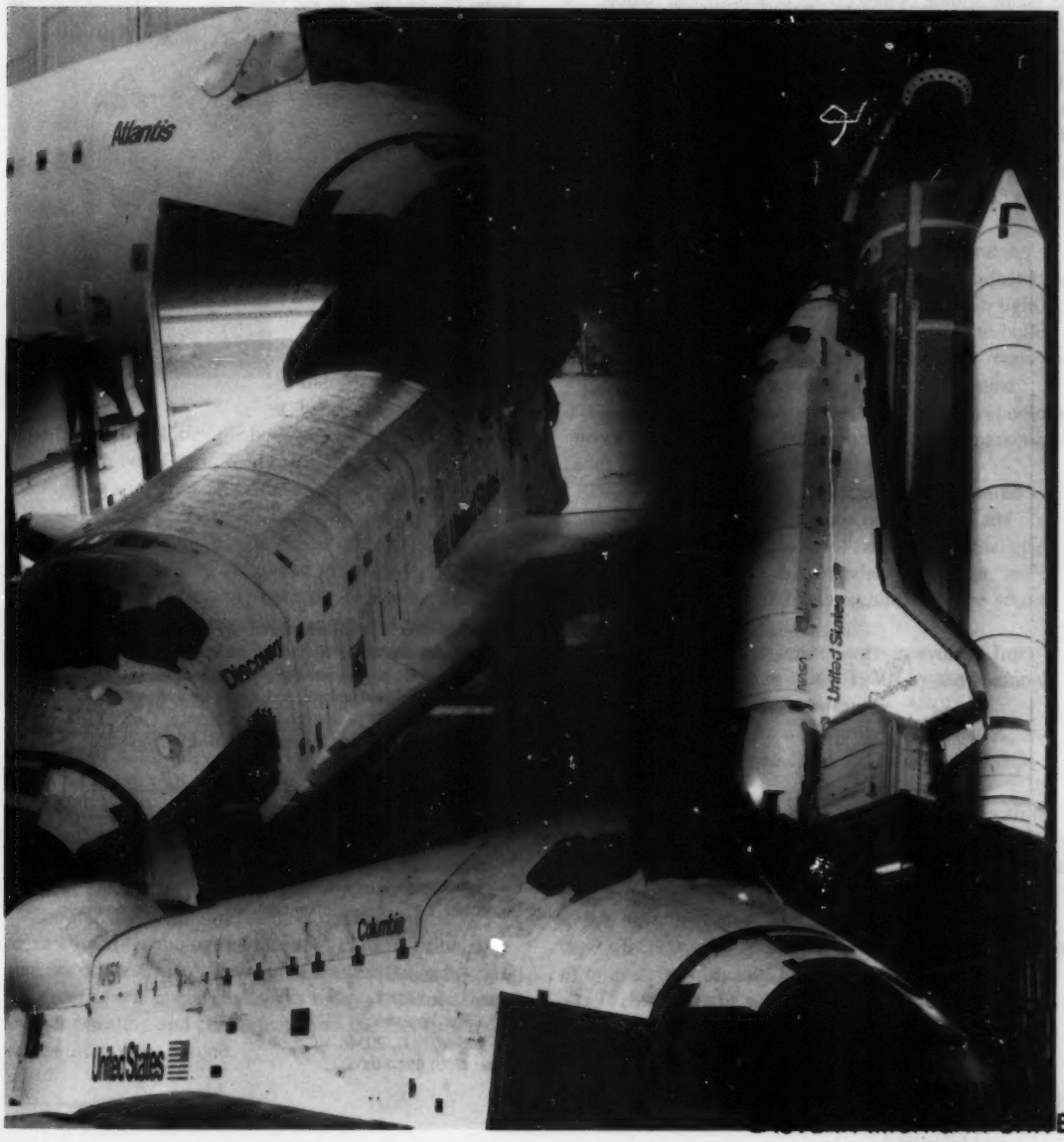

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About the Cover

America's Space Shuttle fleet comprising Atlantis, Discovery, Columbia and Challenger are pictured together for the first time at NASA's Kennedy Space Center.

NASA's fleet is ready to serve as the workhorse for mankind's future endeavors in space. Deploying communications satellites linking nations together, conducting research to unlock the mysteries of the Universe, and performing experiments that may hold the key to prevent or cure human ailments are just some of the major Shuttle contributions benefiting our nation.

The fleet exemplifies our nation's superior technology at work, exploring the last great frontier of space. Living up to its reputation as a reusable space vehicle, the Shuttle will assist in the construction of the Space Station, the next logical step in space.

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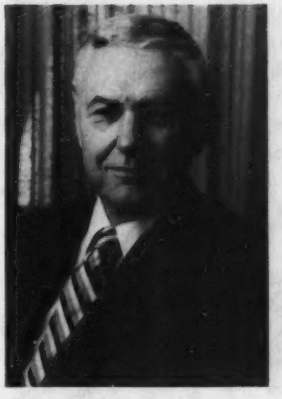
Administrator's Column

(In this column, NASA Activities features an article by NASA Administrator James Beggs. These articles focus on subjects chosen by him that address topics of broad interest to the agency's employees. The column this month features an address presented to Town Hall of California.)



The Rotorcraft Industry

I am delighted to have this opportunity to join in this celebration of 2 decades of a most productive and mutually beneficial relationship. Indeed, it has been a happy union of talent, expertise and facilities for both NASA and the Army. We've both benefitted greatly, but the nation has been the biggest winner of all. And we can be proud of that.

Nearly 2,000 years ago, Cicero, the greatest of Roman orators, said: "There is no more sure tie between friends than when they are united in their objects and wishes." That has certainly been the case with the NASA-Army Joint Cooperative Agreement.

As we look back on the history of the agreement, we can be proud that it has not only strengthened our joint ties, but provided untold benefits to the aeronautical research community and to the country. You have heard much about that history and our mutual accomplishments today, so I don't go around that course again at length.

Rather, I'd like to focus on why we conduct rotorcraft research in the first place; what gains we can anticipate from our efforts and what could lie beyond the next generation of rotorcraft.

Continued growth and progress in aeronautical research and technology is essential to the continued success of the United States civil aeronautics industry. And one of our major challenges today is to keep that industry healthy and cost-effective in the face of strong competition from abroad.

It is terribly important that we do this. For air transportation is a key element in the United States economic infrastructure. Much of our commerce at home and abroad moves by air. The aerospace industry employs more than 1.2 million people and accounts for 2.5 per cent of our G.N.P. Moreover, American aircraft are second only to agriculture in export value and thus play a vital role in trade. And, as we all know, the aeronautical industry spawns high technology innovation in a wide variety of industrial applications.

The rotorcraft industry is a vital leg of both our civil and military air establishments. On the civil side, helicopter sales totaled $336 million last year and that figure is projected to increase to $536 million this year.

Those figures may sound rosy. But, for the longer-term, the economic outlook for our rotorcraft industry is not bright. American-made helicopters face intense competitive pressures from abroad. The United States' share of the international market has declined from more than 80 per cent in 1970 to about 55 per cent today. It is currently projected to dip to about 35 per cent by the year 2005.

Foreign government subsidies and the favorable financial arrangements they provide their manufacturers have contributed to our decline in this area. To fight back effectively, it is clear that we will have to build better and smarter machines than those of our rivals and sell them at competitive prices. In short, we must develop and incorporate new and innovative technology into our helicopters and move them into the market faster than we do today.

The NASA-Army Joint Agreement has given us a solid foundation to build a rotorcraft research and technology base to enable us to take on that challenge with confidence. From that foundation, we can, indeed, build a rotorcraft research and technology base second to none.

Our current joint rotorcraft program evolved from autogyro research begun in the 1930s by the National Advisory Committee on Aeronautics, NASA's predecessor agency. As work progressed, NACA, and later, NASA, developed close ties to military R&D groups.

In 1965, NASA formalized its relationships with the Army in the Joint Agreement. The goal was "to achieve tangible economies and promote efficiency with respect to continuing R&D of aeronautical vehicles."

We have done that. The agreement has been cost-effective. And it has worked to benefit the interests of both signers because it gives each a free hand to adjust readily to the others' needs without undue restrictions.

Euripides wrote: "Joint undertakings stand a better

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chance when they benefit both sides." That has been the key to the success of our joint undertaking.

Two major experimental aircraft programs jointly funded under the agreement are the Tilt-Rotor and the Rotor Systems Research Aircraft. Both have been highly successful, largely because the agreement allows us to capitalize on NASA's unique research facilities and on both the Army's and NASA's strong R&D capabilities.

We have made great progress together. We have used the 40 × 80 wind tunnel for large-scale or full-sized tests; the Transonic Dynamics Tunnel for aeroelastic tests; and the Vertical Motion Simulator for flight characteristics.

We have both learned much from flight research vehicles and from high-speed computational facilities, here at Ames and at NASA's Lewis and Langley Centers and at the Army's Aviation Applied Technology Directorate at Fort Eustis, Virginia.

Our ongoing joint research activities continue to grow, particularly in the areas of crew station research, advanced rotor designs, composite applications and small engine technology.

Technology improvement is the key, not only to advancing our market share in the world, but to greater and more sophisticated uses for rotorcraft.

Over the past decade, rotorcraft use has expanded greatly, in both the military and civil arenas. Rotorcraft now are an integral part of our combat capability. Civil applications range from commuter transportation and forestry to resource exploration and development and emergency medical services.

In the future, we can expect that even more uses will be found for rotorcraft in both cities and rural areas. Clearly, technology improvements are essential if American rotorcraft are to remain competitive in the world. Such improvements will result in increased productivity at lower unit costs.

Our goals must include quieter, safer and more fuel-efficient vehicles that operate with less vibration than those of today. We must aim for higher speeds, greater range, longer endurance and an all-weather capability. We must ensure greater reliability and reduced maintenance requirements.

And for the military, we must find ways to attain low observability as well.

Those goals are ambitious, yet achievable. They can be attained if we concentrate skills, imagination and resources on such vital areas as aeromechanics, automation, propulsion systems, and innovative configurations.

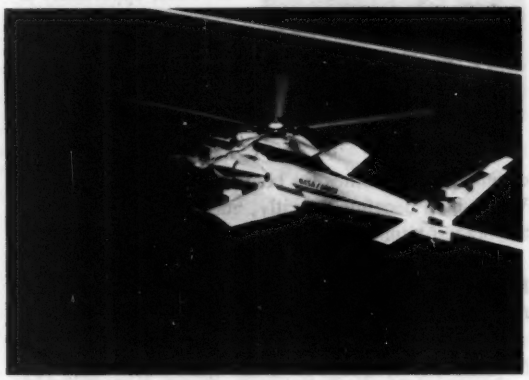
There is much to do in each of these areas. Let me give you a few examples.

In the area of aeromechanics, we need to work to better understand three-dimensional, unsteady flow effects, airload pressure distribution across the rotor and coupled rotor/airframe response characteristics.

In the field of automation, we must apply revolutionary advances in electronics to improve mission performance and safety. Here, especially, we need design guidelines for visual, auditory and tactile information transfer systems.

The propulsion system is the heart of a rotorcraft. These systems are very expensive and cost a lot to maintain and operate. We can improve them and lower their costs through better internal flow analyses and use of advanced materials, such as composites and ceramics in engine components.

To reach the high-speed cruise flexibility of modern fixed-wing aircraft and still hover efficiently, we must be innovative in our designs. We have successfully demonstrated the Advancing Blade Concept, or ABC, and tilt-rotor technologies and will soon fly the stopped-rotor X-Wing. We must move these configurations rapidly from the research arena into operational use.



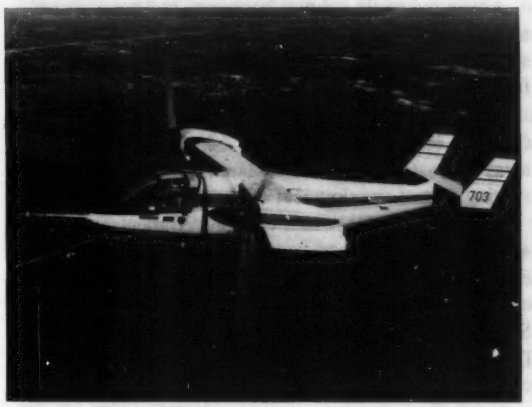
The Rotor Systems Research Aircraft (RSRA) takes off from NASA's Ames Research Center. It was developed to test advanced helicopter rotor systems under actual flight conditions. The RSRA flies as a helicopter, as a compound helicopter (with wings and auxiliary engines) or as a fixed-wing airplane.

Application of these advanced technologies to the next generation of rotorcraft would provide dramatic benefits. They would reduce external noise and fuel consumption by half and attain vibration levels of less than ±.05g, or about the same level of smoothness as a modern-day jet aircraft. We would have rotorcraft capable of operating normally under all weather and environmental conditions, with a 40 per cent improvement in reliability and maintainability.

Such improvements translate into the all-important bottom line: greater productivity, probably a four-fold

increase for helicopters and nearly a six-fold increase for advanced configurations.

Let me turn briefly now to what we can expect to see in rotorcraft beyond the next generation, beginning in about the year 2025 and beyond. There is no question that by then, advanced technology applications will have improved design, development and operating capabilities to a degree we can hardly imagine today.



The Tilt-Rotor Research Aircraft has helicopter-like rotors which tilt up for vertical takeoff and landing. The rotors also tilt forward for conventional horizontal flight, enabling speeds up to 350 miles per hour.

Design will probably be automated, thus reducing much of the laborious, repetitive work we do today. Automation in manufacturing will also ensure high quality in volume production.

Crews will be trained and designs will be developed with the aid of high fidelity, ground-based simulators.

We can also expect widespread use of such advanced materials as polymers that "heal" themselves; electric propulsion systems; and artificial intelligence applications; some perhaps using biocomputer chips.

And, with a second-generation X-wing, ABC or tilt-rotor, we will be flying much faster, approaching or possibly exceeding transonic speed.

Some 300 years ago, Baron von Leibnitz, the German philosopher and mathematician wrote: "The present is great with the future." And so it is with us today.

Our challenge is to continue to build a firm foundation for new generations of American rotorcraft; faster, safer, more flexible and more efficient than any on the drawing boards today.

Working together, I am confident we will meet that challenge. NASA/Army cooperation, which has proved so fruitful over the past 20 years, will continue to grow, paving the way for a new era of rotorcraft for tomorrow.

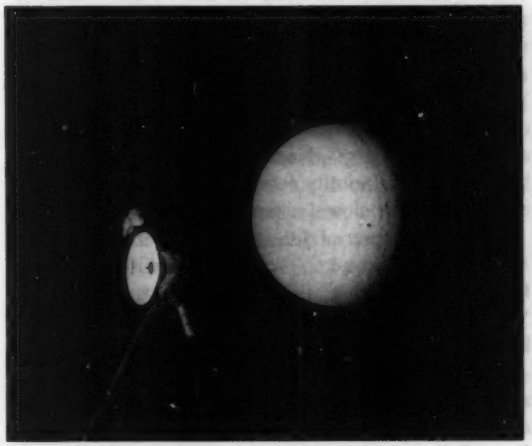
Focusing On Uranus

Uranus, the ringed gas giant that rotates on its side, is the next planet targeted to become a place, rather than a point of light, under the gaze of the camera mount aboard Voyager 2.

The venerable deep space probe, hurtling along at 45,000 miles an hour, is now just 3 months from its close encounter with Uranus. The close encounter will take place at the same time as Earth turns an eye to Comet Halley, and as NASA readies the first polar Shuttle flight. The spacecraft will pass within 66,000 miles of the planet at 10 a.m. PST on Jan. 24. The signal will take 2 hours, 45 minutes to travel from the spacecraft to Earth. The encounter ends Feb. 25, 1986.

The twin spacecraft Voyagers 1 and 2 were launched in August and September 1977 on trajectories that would take them to Jupiter and Saturn, then deliver each spacecraft to explore different regions of space outside our solar system. Voyager 1 has completed its planetary encounters and is returning information as it travels upward through unexplored space in a path away from the ecliptic plane. It will eventually reach interstellar space.

Meanwhile, Uranus and Neptune have been added to Voyager 2's itinerary. After its Uranus encounter, the spacecraft, its flight path changed by that planet's gravity and gaining velocity from the planet's orbital motion, will arc toward Neptune, which it will encounter on Aug. 24, 1989. These gravity-assisted trajectory changes, which require passing each planet at a precise point in space, are the key to Voyager 2's ability to visit all four giant planets in only 12 years.



Artist concept of Voyager encounter with Uranus.

Like Voyager 1, Voyager 2 will head for interstellar space after its planetary encounters.

Uranus, the seventh planet from the Sun, orbits at an average distance of 1.8 billion miles over an 84-year period.

Measuring 32,000 miles in diameter, it is the third largest planet in the solar system, about 64 times the volume of Earth.

Unlike any of the other planets except Pluto, Uranus lies on its side. Scientists theorize that in an early stage of its formation, it could have been tipped off of its original axis in a violent collision with another body. Currently, the planet's southern pole faces Earth.

The planet was discovered by English amateur astronomer William Herschel with a home-made telescope on March 13, 1781. His discovery doubled the size of the known solar system, which at that time ended at Saturn.

At least nine thin, black rings surround Uranus; they are among the darkest objects in the solar system. Only three are somewhat circular. The rest are eccentric. The outermost is most dramatic, varying in width by tens of miles.

The ring system was found in 1977 when Uranus passed in front of a bright star, affording astronomers the opportunity to detect the rings as starlight flashed between them.

Scientists assume that because auroral activity has been detected at Uranus, it must possess a magnetic field. (Auroras on Earth and Saturn are caused by the interaction of their magnetic fields with the stream of atomic particles emitted by the Sun, called the solar wind.)

Voyager 2 carries instruments to conduct 11 experiments. Among them are television cameras, infrared and ultraviolet detectors, and a communications system that doubles as a radio experiment. Three sets of twin computers govern the spacecraft's position in space and its communications and experiments.
Voyager will fly in and out of the Uranian family of rings, moons and planet in a matter of hours, like an arrow through a target. Nearly all the observations of highest scientific priority occur in the 4 hours before and 2 hours after closest approach to the planet.

Richard P. Laeser of JPL is the Voyager Project Manager. Dr. Edward C. Stone of the California Institute of Technology is Project Scientist. The Voyager Program Manager at NASA Headquarters is Earl Montoya.

The Voyagers were designed, developed and assembled by NASA's Jet Propulsion Laboratory, which manages the Voyager mission for NASA's Office of Space Science and Applications.

Inside NASA

Lewis Research Center Opens Microgravity Materials Science Lab

A new materials science laboratory has been opened at NASA's Lewis Research Center, Cleveland, to aid scientists in determining on Earth what is and is not feasible for science experiments in space.

The Microgravity Materials Science Laboratory (MMSL) offers a low-cost, low-risk method to test new ideas for materials science research in space before starting formal development efforts.

"The MMSL will permit U.S. government, university and industry researchers to conduct scientific experiments using equipment that functionally duplicates equipment aboard the Space Shuttle," explained Salvatore J. Grisaffe, Chief of the Lewis Materials Division. "Access to such a laboratory will give U.S. companies a competitive advantage in developing better materials through microgravity research."

A functional duplicate may be a reproduction of only that portion of the Space Shuttle equipment in which the actual materials experiment resides (e.g. the furnace system) or be an exact copy of the flight hardware.

The MMSL is one part of NASA's Microgravity Science and Applications Program which fosters research in the science and technology of processing materials in low gravity. The aims of the program are to obtain a clearer understanding of the factors controlling Earth-based processes to guide their improvement; the development of new materials that cannot now be made on Earth; and the evolution of procedures to support long-term space operations.

The goal of the new laboratory will be achieved in two ways:

- U.S. researchers in the industrial, academic, and government communities will be encouraged to submit ideas for microgravity materials science experiments.
- Experiments conducted in the laboratory will provide a means to determine which proposals have the greatest potential for development in the microgravity environment of space.

In the MMSL, a researcher can establish a scientific baseline toward determining the specific role of gravity in a particular experiment. By conducting carefully planned scientific experiments in a 1-g environment on Earth, scientific research will be more precisely defined before moving toward the more costly phase of experimental work in space.

Initially, the MMSL will handle metals, alloys and electronic crystal experiments. Laboratory capabilities will be expanded in the future to include ceramics, glasses and polymers through NASA's Commercial Use of Space Program.

The new MMSL is not the only microgravity research facility at Lewis. Lewis also has two drop towers in which experiment packages can free-fall up to 500 feet, achieving a weightless condition for up to 5 seconds. In addition, the Lewis Lear jet can fly parabolic trajectories to achieve a microgravity environment inside the plane for up to 22 seconds. A typical scenario for a microgravity materials experiment at Lewis would begin by establishing 1-g baseline data in the MMSL and then proceed to the drop towers or the Lear jet to qualify the project for space flight.

The Space Shuttle currently offers up to 7 days for microgravity experimentation. The Space Station eventually will provide a very long-term microgravity research and materials processing capability. However, the most efficient use of such space resources demands that experimental procedures be based on a firm scientific understanding with extensive prior ground-based examination.

Columbia Modified For Reentry Research

Significant changes have been made to Columbia, NASA's first Space Shuttle orbiter, to accommodate three research experiments to measure orbiter aerodynamic and thermodynamic characteristics as it reenters Earth's atmosphere. Researchers will use this flight data to develop future generation space transportation systems.

The most obvious change in Columbia's appearance is a cylindrical housing which replaced the fintip atop the vertical tail. The new experiment pod is approximately 20 inches in diameter and is capped at the leading edge by a spherical dome. The pod contains equipment for the Shuttle Infrared Leeside Temperature Sensing (SILTS) experiment.

SILTS will obtain high-resolution, infrared images of the upper (leeside) surfaces of Columbia's port wing and fuselage as the orbiter reenters Earth's atmosphere. The infrared images will provide detailed temperature maps at the surface of the leeside thermal protection materials. The maps will indicate the amount of aerodynamic heating of the surfaces in flight, acquiring data that cannot be adequately simulated in ground tests.

SILTS images will be obtained by an infrared camera, mounted inside the dome, that will view Columbia's left wing and fuselage through two windows. The windows will be protected from debris during launch by plugs that fill the window cavities. The plugs will be ejected when the experiment begins, and the windows will be actively cooled during reentry by the injection of gaseous nitrogen into the cavities. Experiment data will be stored on a tape recorder.

The experiment will be initiated by Columbia's computer at the time of entry interface, about 400,000 feet above Earth. It will end after the orbiter passes through the period of significant aerodynamic heating.

A less obvious change to Columbia is a completely new nosecap to house the Shuttle Entry Air Data System (SEADS) experiment. The nosecap has 14 penetration assemblies distributed about its surface, each containing a small hole through which local surface air pressure will be measured during reentry.

Measurement of the distribution of air pressure about the nosecap will allow precise post-flight determination of the orbiter's attitude relative to the oncoming airstream and the density of the atmosphere through which the vehicle has flown.

Accurate knowledge of these factors, coupled with vehicle motion information measured by a separate experiment, are required to determine orbiter aerodynamic flight characteristics. The lack of accurate air data has prevented scientists from determining exact orbiter inflight aerodynamic characteristics. SEADS will provide accurate data from an altitude of about 56 miles through landing.

A third experiment, not visible from outside the orbiter, is inside the nose wheel well. The Shuttle Upper Atmosphere Mass Spectrometer (SUMS) will complement the SEADS experiment by providing atmospheric density information at altitudes above 50 miles.

SUMS will sample air at Columbia's surface through a small hole, located just aft of the nosecap, to measure the number of molecules of various gas species. The information will be used to determine the atmospheric density that, with vehicle motion information, will allow determination of orbiter aerodynamic characteristics at altitudes where the atmosphere is extremely thin. Aerodynamic flight at these altitudes cannot be simulated in ground tests.

The SUMS instrument is a mass spectrometer originally developed for the Viking spacecraft that landed on Mars in 1976. It has been modified to operate in the reentry flight environment of the orbiter.

The experiments were developed at NASA's Langley Research Center, Hampton, Va., as part of the Orbiter

Experiments Program, managed by NASA's Office of Aeronautics and Space Technology, Washington, D.C.

Columbia spent the past 18 months at Rockwell International Corp.'s facility in Palmdale, Calif., receiving these and other extensive modifications. Recently transferred from Palmdale to Kennedy Space Center, Fla., Columbia is scheduled to return to space in December 1985.

Rockwell Selected For Shuttle Operations Contract

NASA selected **Rockwell Shuttle Operations Co.,** Houston, Texas, for negotiations leading to an award of the Space Transportation System Operations Contract (STSOC) at the Johnson Space Center, Houston. Other team members include Bendix Field Engineering Corp., Columbia, Md.; System Development Corp., Camarillo, Calif.; Omniplan Corp., Santa Monica, Calif.; RMS Technologies, Inc., Landover, Md.; and System Management American Corp., Norfolk, Va.

The 2-year award, with a 2-year priced option, will be for services beginning Jan. 1, 1986. Rockwell's proposal reflected a 4-year cost of approximately $685 million. Ultimately, follow-on awards could result in a total contract period of 15 years.

Johnson will manage the work under a cost-plus-incentive/award-fee contract arrangement which includes incentive fee on sound cost management and an award fee on the basis of performance.

Rockwell would be responsible for the performance of six major STSOC functions. Those functions are: (1) project management; (2) maintenance and operations; (3) sustaining engineering; (4) flight preparation requirements and analysis; (5) flight preparation production; and (6) direct mission operations, testing and support. The work involves such major facilities as the Mission Control Center, Shuttle Mission Simulator, Shuttle Avionics Integration Laboratory, Software Production Facility, Central Computing Facility, and the Mockup and Integration Laboratory.

This selection represents the consolidation, into one contract, of work being performed by 16 firms under 22 contracts.

In addition to Rockwell, proposals were submitted by Ford Aerospace and Communications Corp. Space Information Systems Division, Houston; Grumman Space Operations Corp., Houston; and Lockheed Space Flight Co., Houston.

Heard From Around the World

. . . (from non-NASA sources)

Toyko — Japan launched its second comet-watcher space probe on a 7-month rendezvous with Halley's comet next March. Called Suisei, the probe joins its sister craft, Sakigake, and four other spacecraft in an international study of the comet. Japan will share its data with other nations in the project, including the Soviet Union, the United States, and a group of West European countries.

Suisei is programmed to close to within 200,000 kilometers of the comet on March 9, 1986. Using ultra-violet cameras, Suisei will study how water vapor is formed and how much hydrogen is shed by the comet as it streaks past the Sun. Sakigake will probe the tail and the surrounding solar wind from about 7 million kilometers from the comet.

Halley's comet, which circles the solar system every 76 years, will be closest to the Sun on February 9, trailing a long tail of water vapor and hydrogen in a spectacular heavenly show that is expected to be clearly visible from Earth.

Stockholm — The first Swedish satellite, Viking, is scheduled to be launched November 15. Launch will be piggy-back with the French remote-sensing spacecraft, Spot, on an Ariane launch vehicle from Kourou, French Guiana.

Viking will perform measurements in the fields of magnetospheric and auroral research, from a 14,000 by 822 km orbit inclined 98.7 degrees. Simultaneous measurements of electric and magnetic fields, charged particles, plasmas, and their fluctuations as well as ultraviolet images of aurora will be obtained by the six onboard experiments.

Rio De Janeiro — The Aerospace Technological Center of Sao Jose Doe Campos will launch its second Sonda IV space booster on November 19, this one carrying a 500-kg scientific payload. This test series is aimed at a 1989 orbiting of a Brazilian domestic satellite. The November launch also will include studies of payload recovery by parachute and will test devices for future Space Shuttle missions. The 2-stage, 12-meter-high rocket weighs 7,300 kg and is capable of reaching altitudes of 600 to 700 km.

Tokyo — Japan's space agency has announced three final candidates, including one woman, for a January 1988 flight aboard Space Shuttle Columbia. Either

Takao Doi, 30, Mamoru Mori, 37, or Chiaki Naito, 33, will become Japan's first astronaut.

Naito, the female candidate, is an assistant at Keio University's Medical School. Doi is serving as a National Research Council Associate at NASA's Lewis Research Center. Mori is an assistant professor of nucleonics at Hokkaido University. Final astronaut selection is slated for May 1987.

From the Chief Engineer

. . . Dr. Milton A. Silveira

The NASA Excellence Award For Quality and Productivity

One of the major goals of the agency is to put the United States on the cutting edge of high technology and thus, keep our economy strong and competitive. This not only implies the development of advanced hardware and processes, but the assurance that these products will be of the highest quality.

Foreign competition in space is increasing at a much faster rate than in the past. Unless we maintain our vigilance and continue to improve our products, it will not be long before we will have some real competition in space as we have had in automobiles, steel, electronics, and other commercial goods.

The decision to conduct the NASA Excellence Award Program emanated from a series of NASA/contractor conferences held over the last 2 years. The objectives of those meetings were two-fold: first, to identify impediments to productivity and find ways to alleviate them; and second, to exchange ideas and approaches for quality and productivity improvements.

One way to promote these objectives is to recognize those organizations that have made outstanding contributions to quality and productivity. This award program will assist in that recognition role.

Over 85 percent of the NASA budget is spent by private industry which has assisted us in achieving the outstanding record in space over the last 27 years of NASA's existence.

The NASA Excellence Award was formally announced by Mr. Beggs at the NASA Symposium on Productivity and Quality held on September 25-26, 1984. The objectives of this award are to: (1) create public awareness of the importance of quality and productivity to the United States in international economic competition; (2) encourage industry to seek excellence in products and services; and (3) promulgate award winners' methods of achieving quality and productivity excellence. The award application guidelines were developed by an ad hoc working group of the NSIA/AIA-NASA Liaison Panel and reviewed by an independent group of experts from industry, Government, and academia. NASA installations and Headquarters offices submitted comments, as appropriate. Over 20 corporate chief executive officers responded favorably in support of this award program. For FY 1985, this award will be limited to hardware contractors and subcontractors. Guidelines are being developed for service contractors who also will be eligible for the award in 1986.

The Japanese long ago recognized the importance of rewarding outstanding companies. Since 1951 they have been awarding the Deming Award, named after an American, to outstanding companies in the area of quality.

The NASA award not only focuses on quality, but it takes it one step further by emphasizing that improved quality affects productivity in a positive way.

The call for self-nominations elicited 47 responses from our contractor and subcontractor team. Both large and small businesses were included in this group. Well over half of the hardware contractors were from the list of top 50 companies, in dollar volume, doing business with NASA. We will expect that next year will see a significant increase in the number of applications for this award since non-hardware (service support) contractors and subcontractors also will be eligible for the award.

The Award Evaluation Committee is currently reviewing the finalists in this competition, which includes on-site verification visits to document accomplishments of the leading contenders.

The award winners will be announced by Mr. Beggs in January 1986. The number of awardees is not fixed but will reflect the number who are able to achieve the highest degree of excellence in quality and productivity.

The program is being managed by the Office of the Chief Engineer, Reliability, Maintainability and Quality Assurance Division.

The American Society for Quality Control (ASQC) is assisting NASA in the administration of this award program and providing technical expertise. The ASQC draws on its experience as one of the leading quality

organizations in the world with over 45,000 individual and 360 sustaining corporate and organizational members.

Research And Technology To Improve Shuttle Main Engine

Mention Space Shuttle and most people think of spectacular launches from Kennedy Space Center. NASA's Lewis Research Center in Cleveland, however, also is very much involved in the Space Shuttle program in equally important ways.

In a joint effort with NASA's Marshall Space Flight Center in Huntsville, Ala., Lewis is pursuing a program to improve Shuttle engine performance, reduce operational costs and to develop advanced engine technology for future space travel.

Though the Space Shuttle propulsion system has performed flawlessly for many space missions, the engine's operational life and performance levels still can be improved.

According to Stanley J. Marsik, Lewis' Space Shuttle Main Engine Technology Program Manager, "The current engine represents the first generation of reusable engines. In a way, the first reusable space engine can be compared with the Model-T automobile. Now that we have experienced numerous flights with this engine, we have learned how to improve its life and performance. We now are working towards advancing the technologies necessary to support those improvements."

Although the current Space Shuttle main engine is the most sophisticated rocket engine in use today, it incorporates the state-of-the-art technology at the time of its development, some 15 years ago.

In this new age of engine reusability, demands will increase for higher performance with lighter weight components. These requirements result in higher operating pressures and temperatures as well as increased mechanical vibrations, fuel flow turbulence and severely taxed engine components such as turbine blades, bearings, seals, fuel ducting and combustion chambers.

Engineers are studying new high-temperature, high-strength metal alloys and other advanced materials such as new protective coatings, and new combustion processes. Advanced computer modeling techniques study loads on turbine blades and fuel flow.

Researchers are examining use of a hydrostatic ball bearing wherein a film of gas would separate the bearing from metal surfaces, resulting in no metal-to-metal contact.

New methods of measuring wear and deterioration are being studied so that parts are replaced only when absolutely necessary.

Engineers also are studying ways to monitor engine health by installing a series of computer-connected diagnostic sensors on the engine to signal deviations from normal performance and to facilitate more economical on-the-ground maintenance.

Ten disciplinary groups have been formed at the two NASA centers to work with some 130 different technology elements of engine design.

The engine builder, Rocketdyne Division of Rockwell International, other NASA contractors and several universities are supporting the program to advance these technologies.

The 10-year program is scheduled for completion in 1991. Technology developed may be the foundation for an engine in the next decade to carry humankind to the Moon, Mars and beyond.

Young Minds Challenge Bold Ideas

Two NASA university programs, primarily involving undergraduate students, combine futuristic space frontier concepts with realistic engineering design challenges.

The first program, co-sponsored by Headquarters, Ames Research Center, and Johnson Space Center required students to design a spacesuit glove which would allow astronauts maximum flexibility at 8 p.s.i., the pressure planned for future extravehicular activity. Ten universities responded with proposals. The design competition was won by the Kansas State University team.

The second, broader program is now entering its second phase of a 2-year pilot effort. In this program, NASA advanced space design projects are adopted by universities as topics for senior design classes. Each university receives a grant and is aligned with a NASA center which provides guidance, data, and lecturers during the academic year and 10-week summer work assignments for three students. The center work period extends and refines work done during the school year.

The initial group of participating centers, schools, and projects are:

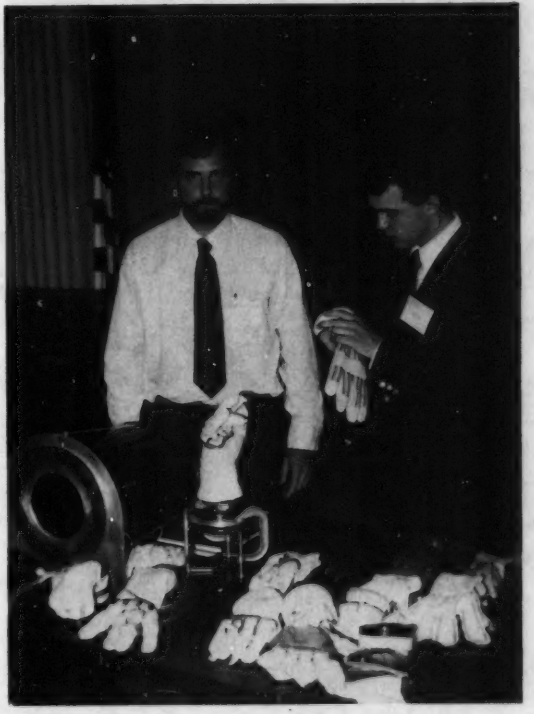
University of Wisconsin	Manned Mars Habitat	ARC
University of Colorado	Geosynchronous Space Station	ARC

Virginia Polytechnic Institute	Orbital Servicing Center	LaRC
Massachusetts Institute of Technology	Lunar Base – Manned Mars Mission Asteroid Mission	LaRC
Georgia Institute of Technology	Lunar Site Preparation	MSFC
University of Washington	Space Manufacturing Facility	LeRC
University of Michigan	Lunar Space Transportation System	LeRC
University of Texas and Texas A & M	Manned Mars Mission	JSC

Students and professors from participating universities met with NASA personnel at the Kennedy Space Center for a 3-day workshop in July. The students presented the results of their design studies and participated in workshops led by Mike Duke (JSC), Frank Swalley (MSFC), and Mel Averner (HQ). Also featured were briefings on future projects by Stan Sadin (HQ) and Barney Roberts (JSC) plus a presentation by astronauts Marsha Ivins and Mark Brown.

Activities are underway for the next academic year with Goddard Space Flight Center, Kennedy Space Center, and Jet Propulsion Laboratory and seven additional universities joining the program.

The NASA/University Advanced Design Project is funded by program offices and The Office of External Relations and is administered by the Headquarters University Programs Office and the Universities Space Research Association.



Jon Held, graduate student from Kansas State University, shows the prototype of the winning glove design to Robert Cote from the University of Oklahoma, who also participated in the design competition.

Air And Space Museum Trophy

Robert R. Gilruth, Kathy Sullivan, and Bruce McCandless were selected to receive the newly created National Air and Space Museum Trophy for their achievements in the fields of aerospace science and technology.

Astronauts Sullivan and McCandless shared the award for their contributions to the current Space Shuttle program. Gilruth was selected for his outstanding leadership in the space program in its early years.

The presentation took place earlier this month at the museum in Washington, D.C.

The NASM Trophy, sponsored this year by the Federal Express Corp. and Delta Airlines, will be awarded annually for achievement in the following areas:

- Management of scientific or technological projects relating to air and space
- Execution of such projects by the team and crew members involved
- Attainment of distinction not only by a single extraordinary act but also by a career of service in the field of air and space technology, including management
- Chronicling the history of air and space science and technology.

The trophy itself, entitled "The Web of Space," was created by Washington, D.C. sculptor John Safer. It consists of two open half circles of polished steel, set at right angles to each other and supporting in the center, by a series of thin steel rods, a small polished sphere. The trophy will be exhibited in the museum's south lobby.

Sullivan was the first American woman to walk in space, in October 1984 on Space Shuttle flight 51-G. During that flight, Sullivan and fellow astronaut David Leestma tested an orbital refueling system for use on

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satellites and on a future space station.

McCandless flew for the first time in February 1984 aboard Space Shuttle flight 41-B. McCandless became the first person to test-fly in space a manned maneuvering unit, which he helped develop.

Gilruth joined the staff of the Langley Memorial Aeronautical Laboratory in 1936. There, he specialized in structures, dynamic loads and pilotless aircraft. In 1958, he became director of NASA's Space Task Group, the organization responsible for Project Mercury. Under his leadership, the Mercury spacecraft was designed, developed, manufactured, and successfully flown. From 1961 to 1971, Gilruth was director of the Manned Spacecraft Center in Houston, Texas, where he was responsible for the Mercury, Gemini and many Apollo missions.

A panel of distinguished judges made the selection of the awardees. The judges were: James Van Allen, world-renowned physicist and discoverer of the Van Allen Radiation Belts; Betty Skelton Frankman, former women's aerobatic champion; Sen. John Glenn, former Mercury astronaut; Faye Gillis Wells, pioneer aviator; Gen. Benjamin O. Davis, commander of the first black fighter squadron; Lew Allen, director of the Jet Propulsion Laboratory and former Air Force Chief of Staff; William H. Gregory, editor-in-chief, Aviation Week and Space Technology, and Thomas O. Paine, former administrator of the National Aeronautics and Space Administration.

Did You Know?

The space program has a special opportunity to provide an example and inspiration in the difficult task of overcoming America's declining productivity, NASA Administrator James M. Beggs recently told representatives of some of the Nation's leading corporations meeting at the 2nd Annual NASA Contractors Conference held at the Marshall Space Flight Center and the Kennedy Space Center. In all, more than 120 contractors and representatives from every NASA installation attended the sessions, for a total of more than 320 people.

The conferences were composed of panels representing organizations taking an active interest in formalizing the process to improve quality and productivity. Panel presentations focused on themes such as, "Productivity and Quality Initiatives," "Participative Management and Middle Management," and "Incentives for Productivity and Quality." The panels specifically explored:

- Quality/productivity improvement programs within supplier/vendor organizations and program impact on NASA/contractor excellence goals.
- Strategies for placing the responsibility for quality on the supplier.
- Successful quality teams and suggestion programs.
- Management leadership in PIQE and white collar productivity improvement.
- Performance measurement and tracking, and advances made in streamlining specifications.

Mr. Beggs' remarks and those of key speakers and panelists are available on a series of seven audio cassettes. These tapes can be obtained from each installation Productivity Focal Point. In addition, Productivity Focal Points have printed copies of the complete Conference Proceedings.

NASA is now providing relocation services which will ease the financial risk and personal stress for employees who move in the interest of the Government. All of the services are available to current Federal employees who relocate for NASA, and many of them may also be utilized by new hires.

For current employees, a primary benefit not previously available, is a guaranteed timely buyer for one's present residence. Under NASA's agreements with Home Equity and Chem Exec Relocation Services, Inc., one of them will purchase the residence at fair market value if the employee does not have another buyer and accepts their offer. It is possible that an employee could have a check for the full equity in his or her home as soon as 30 days from the date of the decision to accept a position in a new location. The relocation companies also provide rental management services should an employee desire this alternative.

For both current employees and new hires, the contractors are available for professional, service-oriented counseling and assistance in home selling, home finding in the new location, and mortgage finding. Spouse employment counseling assistance is available for an employee-paid fee.

Each NASA installation has designated a relocation services coordinator. Employees who anticipate a permanent change of station move should contact their personnel office for additional information.

NASA participation in the 33rd EAA/International Convention and Sport Aviation Exhibition was a major highlight of the event. Held between July 26 and August 2, this celebration of flight drew nearly a million aviation enthusiasts, including 2,000 visitors from 66 foreign countries.

The balance of the statistics were overwhelming. About 15,000 airplanes flew in for the event, 1,760 of these were registered as show planes. During the 8 days, the FAA recorded 64,416 landings and takeoffs.

Centerpiece of the NASA pavilion area was a 5,400-square-foot tent featuring NASA's latest research and technology in both the aeronautics and space areas. The theme was "The Shape of Things to Come."

Although Lewis was the lead center for NASA's presence at Oshkosh '85, a dynamic team effort included Langley, Ames, Johnson, Marshall, Goddard, JPL and Headquarters personnel and exhibitry.

Contractor News

NASA's Marshall Space Flight Center awarded a contract to **Perkin-Elmer Corp.** to study concepts and technologies needed for a next-generation telescope with 10 times the capabilities of the Hubble Space Telescope. The 14-month contract is valued at $140,000.

Perkin-Elmer first will examine the probable science to be performed with such a telescope as well as concepts comprising an array of telescopes working together as one.

This study, the first step toward preparing to launch a space telescope array in the first decade of the next century, will define a technology development plan for the telescope array and provide cost and schedule data for NASA.

According to Perkin-Elmer, two different telescope concepts will be developed, based on the best use of the Space Station and technology advancements needed to implement them. The first will emphasize assembly and optical alignment in orbit using the Space Station as the assembly base. The second concept will focus on modularization, ground assembly and checkout, and minimal on-orbit assembly.

The study also will explore the possibilities of adapting, for visible light purposes, interferometer techniques used by radio astronomers to obtain high resolution maps of deep space objects. In addition, Perkin-Elmer will define and recommend technologies needed for maximum use of the Space Station for assembling, testing and servicing the next generation facility for optical astronomy.

The Hubble Space Telescope, scheduled for launch on Shuttle flight 61-J in August 1986, was built by Perkin-Elmer.

Lewis Research Center awarded a $12,386,535 contract to **Teledyne Industries, Inc., Teledyne Systems Co.,** Northridge, California for the fabrication, assembly and test of digital computers and remote multiplexer units in support of the Shuttle/Centaur program.

The sole-source, fixed-price-incentive-fee contract began in July 1985 and will run through October 1987. Work will be performed at the contractor's plant in Northridge, Ca.

Digital computers act as the focal point for the Centaur flight control system, processing data from the other flight boxes including the multiplexer units. They also provide hardware capability to interface with the orbiter and the ground system.

The first Centaur launch from the Shuttle payload bay, the Ulysses mission, is scheduled for May 15, 1986, followed by the Galileo mission on May 21, 1986.

Lewis Research Center awarded a $10,169,016 contract to the **General Dynamics Corporation, Convair Division,** San Diego, Calif., for management and engineering services in support of the Atlas/Centaur launch vehicle program.

In addition to providing the overall program management and administrative and engineering support, it will include technical management; engineering design, analysis and development; engineering test and development and reliability and quality assurance.

The cost-plus-award-fee follow-up contract began in July 1985 and will continue through Dec. 31, 1986.

Work will be performed at the contractor's plant in San Diego, with additional effort at the Eastern Test Range, Florida.

Centaur is a high energy upper stage currently used with expendable boosters to deliver large payloads to geosynchronous orbit. It is currently being modified for use at an upper stage in the Space Shuttle. Introduction of the Shuttle/Centaur combination is scheduled for May 1986 with launch of the Galileo mission to investigate Jupiter's atmosphere and the Ulysses mission to study the polar regions of the Sun.

Lewis Research Center, Cleveland, awarded the **General Dynamics Corp., Convair Division,** San Diego, Calif., a $79,194,665 contract in support of the Shuttle/Centaur program for the period Aug. 30, 1985, through June 1987.

Under the cost-plus-award-fee contract, General Dynamics will supply labor, materials and resources necessary to provide management and engineering services plus launch operations services necessary to implement the Shuttle/Centaur program.

Included in this multi-contract concept are services such as overall program management; administration and engineering support; technical management; operations, planning and integration and launch complex modifications.

Work will be performed at the contractor's plant in San Diego and at the Eastern launch site in Florida.

In May 1986, the Shuttle/Centaur combination will signal the beginning of a new era of exploration of our solar system with the launch of the Ulysses mission. The Ulysses, an international mission, is the first and only planned mission to observe the polar regions of our sun.

The Galileo, scheduled for launch one week later, will explore the Jovian atmosphere. And in the spring of 1988, the Shuttle/Centaur combination will launch the

Venus Radar Mapper mission to investigate the surface and interior of Venus.

Goddard Space Flight Center in Greenbelt, Md., selected the **Computer Sciences Corporation** to negotiate a cost plus award fee contract for the Upper Atmosphere Research Satellite (UARS) Central Data Handling Facility (CDHF) Software System (UCSS).

The contract, expected to be effective in October, will consist of a 5-year period with delivery of the UARS CDHF Software System in approximately 36 months and pre- and post-launch support thereafter. UARS is scheduled for launch from a Space Shuttle in late 1989.

The total proposed cost plus award fee for the contract is $5,759,000.

The contract will provide for the development of applications software for the UARS. The CDHF preforms production data processing of all UARS telemetry data and stores the resulting scientific data products for remote access by the investigators at their Remote Analysis Computers.

1985 Shuttle Launch Schedule

Mission	Date/ Orbiter	Payloads	Crew
61-A	Oct. 30, 1985 *Challenger*	Spacelab-D1	Hartsfield, CDR Nagel, PLT Buchli, MS Bluford, MS Dunbar, MS Furrer, PS (DFVLR) Messerschmid, PS (DFVLR) Ockels, PS (ESA)
61-B	Nov. 27, 1985 *Atlantis*	Morelos-B Satcom KU-1 Aussat-2 CFES	Shaw, CDR O'Connor, PLT Cleave, MS Spring, MS Ross, MS Vela, PS (Mex.) Walker, PS
61-C	Dec. 20, 1985 *Columbia*	MSL-2 Satcom KU-2 Syncom IV-5	Gibson, CDR Bolden, PLT Chang-Diaz, MS Hawley, MS Nelson, MS Cenker, PS Rep. Nelson, PS

1985 Expendable Launch Schedule

Mission	Launch Date	Vehicle	Launch Site
AF-17	Oct.-Dec.	Scout	WFF
NOAA-G	Nov.	Atlas	WSMC
GOES-G	Dec.	Delta	ESMC
Navy-23	Dec.	Scout	WSMC

* **Launch Sites:** KSC — Kennedy Space Center, Fla.; ESMC — Eastern Space and Missile Center, Fla.; SMR — San Marco Range, Indian Ocean; WSMC — Western Space and Missile Center, Vandenberg Air Force Base, Calif.; WFF — Wallops Flight Facility, Wallops Island, Va.

Another Dividend from Air and Space

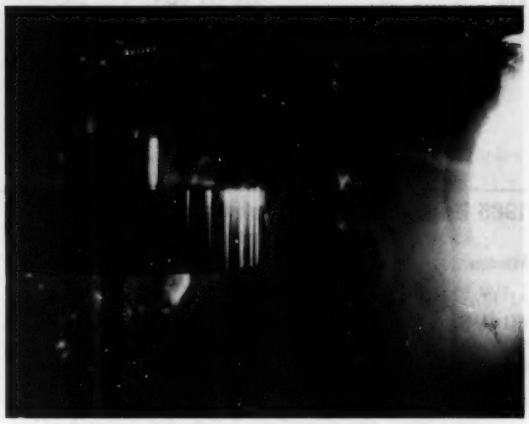
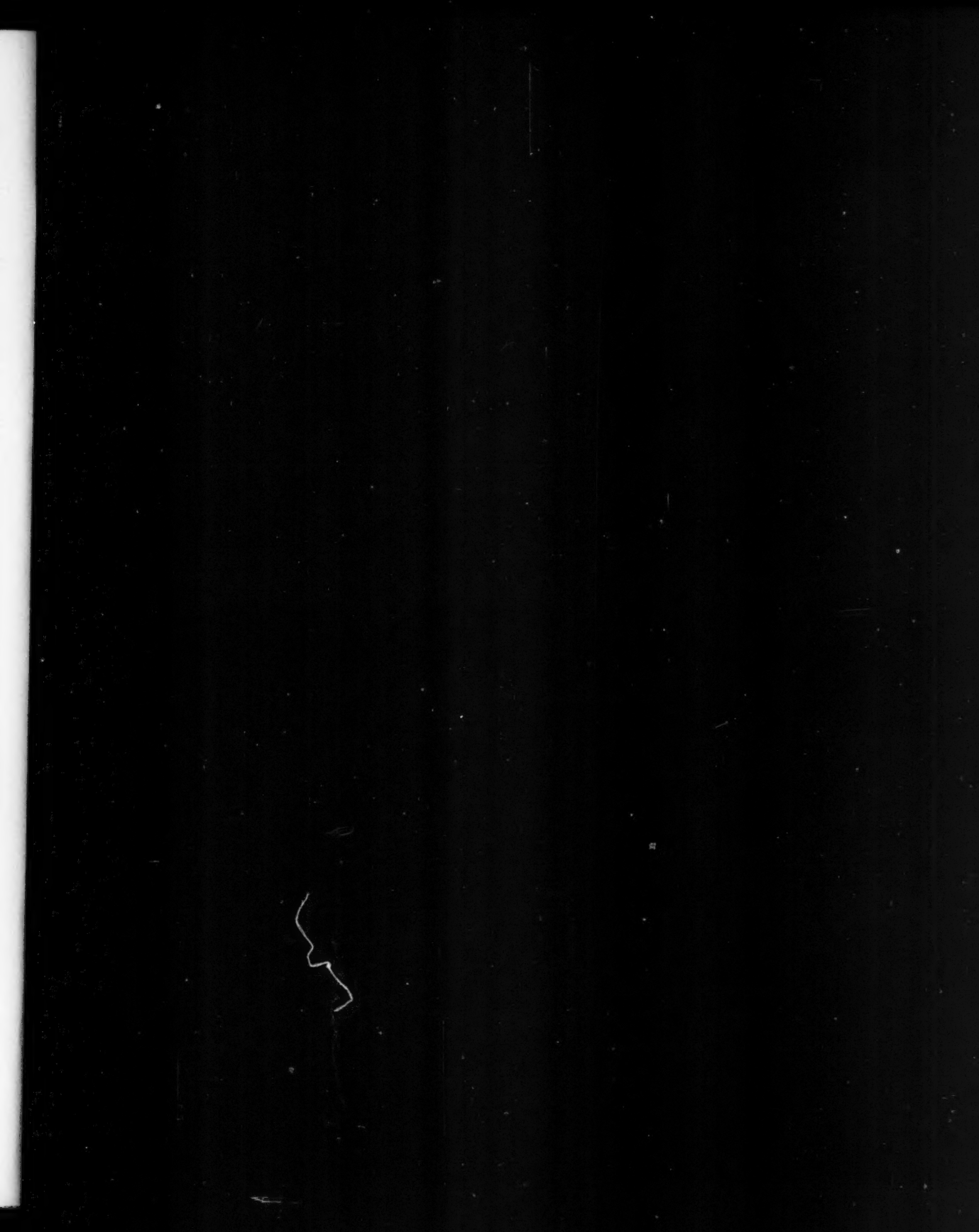
Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

High-temperature Lubricants

In future aircraft flying at three or more times the speed of sound, aerodynamic heating can result in vehicle skin temperatures as high as 1600 degrees Fahrenheit, well above the temperature limitations of airframe bearings. Solid lubricants oxidize or dissociate at temperatures below 900 degrees; other lubricants could meet the temperature requirement, but only after complex and time consuming secondary treatment. Therefore, Lewis Research Center started a program several years ago to develop improved high-temperature lubricants.

A material that emerged from Lewis' research is a plasma-sprayed, self-lubricating metal-glass-fluoride coating able to resist oxidation at very high temperatures. That technology is now in commercial use under the trade name Surf-Kote C-800, marketed by Hohman Plating and Manufacturing, Inc., Dayton, Ohio under a patent license from NASA. Surf-Kote C-800 contains a special sodium-free glass for oxidation protection, silver for protection in the low temperature range and calcium fluoride for high-temperature protection. The coating is intended for service from minus 200 degrees to 1600 degrees Fahrenheit to reduce wear and prevent galling and seizure of metals. Among its uses are lubrication for sliding contact bearings, shaft seals for turbopumps, piston rings for high performance compressors, and hot glass processing machinery. It is also widely used in missile and space applications. Lower left, a Hohman worker is coating a shaft with plasma spray.

Hohman Plating and Manufacturing, Inc. has consulted with Lewis Research Center on vacuum deposited coatings and has adapted NASA technology in several coating areas, such as sputter deposition and ion plating. Sputtering involves bombarding a surface with high energy particles to deposit an extremely thin dry film lubricant. Ion plating is a coating process whereby a metal is vaporized, ionized and attracted to the surface to be coated by the influence of electrical fields. Ion plating allows use of almost any metal that can be melted to coat surfaces with uniform thickness and excellent adhesion. Below, a gear is being ion plated with a soft metal that will act as a dry lubricant. About half of Hohman's ion plating work is for lubrication. Other coatings are for corrosion resistance, electrical conductivity or insulation.



* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.